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ABSTRACT

Cognitive style refers to preferences for, or dominant modes of, information processing. Cognitive styles tend to be bipolar and less value-laden than ability or aptitude measures. Conceptualizations of cognitive style differ in the number of styles and the degree of metacognitive control over them which individuals are presumed to have. The Hill model, the McKenny-Keen Model, and the Cognitive-Dimensions Model are discussed. In particular, the paper describes measures and reviews research pertaining to nine cognitive dimensions identified in an earlier review by Messick: (1) field dependence-independence; (2) reflectivity-impulsivity; (3) scanning; (4) breadth of categorization; (5) conceptualizing style; (6) cognitive complexity-simplicity; (7) leveling-sharpening; (8) distractibility; and (9) tolerance for unrealistic experience. Other cognitive style definitions utilize visual-haptic, analytical-global, and verbal-visual dimensions. Research on relationships among measures is summarized, and their lack of convergence suggests that there are a multitude of cognitive styles or dimensions of cognitive style. The dimensions that seem most conceptually comprehensive and potentially independent are field dependence-independence, distractibility, tendency to use global versus analytical problem-solving strategies, and preferred medium for obtaining information (e.g., visual-haptic; verbal-visual). (LPG)

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COGNITIVE STYLE:
A REVIEW OF THE LITERATURE

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JOHNSON O'CONNOR RESEARCH FOUNDATION

HUMAN ENGINEERING LABORATORY

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Cognitive Style: A Review of the Literature

Kathy E. Green

Abstract: Cognitive style is loosely defined as a person's typical mode of perceiving, thinking, remembering, and problem-solving. This report reviews literature concerning theoretical and operational definitions of cognitive style. A number of styles discussed in the literature are presented. Assessment instruments are reviewed, as are empirical relationships among alternative style measures. Although the construct of cognitive style does not appear to be precisely defined, several potentially useful measures are identified. The report concludes with suggestions for further investigation.

INTRODUCTION

The purpose of this report is to present a review of the literature relating to the theoretical and operational definitions of cognitive style. Definitions of cognitive style strongly associated with personality theory (dogmatism, authoritarianism) are not included. Following the literature review, recommendations are made regarding aspects of cognitive style that may be most promising for further research at Johnson O'Connor.

COGNITIVE STYLES: HISTORICAL CONTEXT

Mental assessment has been used in psychology and education since the late 1800s, originating in the ideas of Ebbinghaus, Webster, and Galton. With the notion of compulsory school attendance becoming generally accepted, Alfred Binet was requested by the French government to identify school children with different levels of ability, and in particular to identify those children who would require individual attention to profit from their education. To carry out this task Binet developed a test of intelligence. Binet was the first to isolate the concept of intelligence from other concepts like soul, mind, and consciousness.

In the early 1900s numerous methods of examining data were introduced, thereby enhancing the development of mental testing. Factor analysis and regression techniques became essential to the assessment of test reliability and to the identification of human abilities. Early investigations of human abilities identified two components: a general ability (g) and task-specific

abilities (Spearman, 1904). Thurstone (1938) applied the new technique of factor analysis to mental test data and identified the primary mental abilities of general reasoning, inductive reasoning, deductive reasoning, verbal ability, numerical ability, spatial-visual ability, memory, word fluency and perceptual speed. Within the "primary mental abilities" mainstream of the 1930s and 1940s, several researchers argued for major group factors (e.g., verbal versus spatial) with task-specific abilities in spelling, mathematics, etc. (Vernon, 1950). Cattell (1963) identified the major group factors as fluid and crystallized intelligence, with fluid intelligence being concerned with spatial-visual perceptions and crystallized intelligence being concerned with verbal and numerical reasoning.

Guilford (1967) found that Thurstone's primary mental abilities were not exhaustive of the factors identified by factor analysis of mental test scores. Guilford proposed a "structure of intellect" (SI) model. This model suggested that intellectual functioning has three dimensions: operations, content and products. Mental operations are cognition, memory, divergent thinking, convergent thinking and evaluation. Content types are figural, symbolic, semantic and behavioral. Products, or forms of information, are units, classes, relations, systems, transformations, and implications. Assuming independence across these three dimensions, Guilford's SI model posits 120 unique abilities (5x4x6).

Guilford was the first to conceptualize intelligence as having a process dimension. Other developments in cognitive psychology (information theory and artificial intelligence) have since led to process being the primary topic of investigation. Information-processing models suggest that information is acted on by mental processes which are directed by executive processes or strategies. Metacognitive processes invoke, monitor, and terminate the entire function. Individual differences in cognitive aptitudes, from an information-processing viewpoint, come from three sources (Hunt, 1978). First, individual differences are based on information differences--the more one knows about a problem to be solved, the more capable of solving the problem one is likely to be. Tests of general knowledge (e.g., vocabulary) assess this component. The second source of individual differences is in the mechanics of information processing--perceiving, encoding, searching memory, retrieving, and outputting information. Hunt, Frost and Lunneborg (1973) found that reaction time to elementary tasks which were essentially information-free, such as identifying A as a, correlated with aptitude test scores. The third source of individual differences lies in the general, as opposed to the elementary, processes used as steps in solving larger problems. Hunt (1978) cites evidence suggesting that people have characteristic ways of looking at problems. These characteristic information-processing styles may be the ones which selectively emphasize the elementary information processes the individual uses well. Newell and Simon (1972) argued that a few, and only a

few, gross characteristics of human information processing are invariant over tasks and individuals. Those characteristics, however, are sufficient to determine a task representation in a task environment. That is, they determine the task setting, or context, and also determine the interpretation of the problem itself. The structure of the task environment determines the possible structures of the problem space, which in turn determines the possible ways the problem may be solved. These executive processes are either determined by cognitive style or are cognitive style.

Cognitive style is a term which originated in personality research but which has been adopted by cognitive psychologists to refer to information-processing habits which represent a person's typical modes of perceiving, thinking, remembering, and problem solving. Cognitive styles are "stable, relatively enduring consistencies in the manner or form of cognition" (Messick, 1969), ". . . an individual's propensity and preference for coming to terms with the data-stimuli of his environment through particular modes of thinking that are partly conscious strategies and partly unconscious habits" (McKenny & Keen, 1974).

COGNITIVE STYLE AND ABILITIES

Cognitive style refers to preferences for, or dominant modes of, information processing. Abilities refer to intellectual capabilities which are somewhat general and underlie performance on many tasks. Aptitudes refer to specific skills which are desirable for proficient job performance. It has been argued that cognitive styles may not be differentiable from abilities and aptitudes (e.g., Kogan, 1971). However, conceptually and historically, cognitive styles and abilities/aptitudes differ in the following ways:

(1) The measurement of abilities tends to emphasize maximum performance. Cognitive style is more concerned with typical or spontaneous behavior.

(2) Ability/aptitude dimensions tend to be unipolar--scales go from little of an ability to a lot of that ability. Cognitive styles contrast the preferred mode of performance with other modes of performance. Cognitive style is less likely to be unipolar.

(3) Ability/aptitude assessment is often value-laden. That is, more of an ability is most often better than less of an ability. For cognitive styles, circumstances determine whether it is better to use one style than another. Value is a function of the situation and the task.

(4) Historically, the concept of abilities has been tied to education. Research in cognitive style has been most often located in the psychological laboratory with the concept developing from personality theory.

(5) Styles exert controls on mental functioning; abilities do not. Styles cut across task domains while abilities are specific to a particular domain of content or function.

There is also evidence (e.g., Federico & Landis, 1980) that while cognitive style is correlated with ability/aptitude, the magnitude of the correlation is low, suggesting that measures of cognitive style provide complementary, nonredundant information.

CONCEPTUALIZATIONS OF COGNITIVE STYLE

Brumby (1982) summarizes four positions regarding cognitive style in statements of the assumptions made by researchers:

(1) There is a single cognitive style, existing on a bipolar spectrum, on which individuals may be consistently placed.

(2) There are different styles, but an individual has only one. An individual's style is stable across situations and time. Different styles are advantageous in different situations.

(3) There are different styles which can all be present in individuals in different degrees. Individuals can be characterized as having "amounts" of these different styles.

(4) There are different styles and individuals select the cognitive style appropriate to the task. This implies metacognitive control over which problem-solving approach will be used and implies that style is context-dependent rather than an individual characteristic.

Failure to find substantial correlation across different measures of cognitive style suggests that either there are multiple dimensions of cognitive style, there are multiple styles, or the measures are not reliable and valid indices of a well-defined construct. Existing models of cognitive style all hypothesize a multidimensional construct. Three models will be briefly described below. Following this, a synopsis of additional definitions will be presented.

The Hill Model

Hill (1970) describes cognitive style as the Cartesian product of four sets. This model bears similarities to Guilford's structure-of-intellect model. Hill's sets are (1) symbols and meanings--words, numbers and personal symbols, (2) cultural determinants of the meaning of symbols--modifications of

symbols due to family influences, friends, colleagues and personal assessment, (3) modalities of inference--deductive or inductive argument, and (4) neurological, electrochemical and biochemical aspects of memory functions. Each set is composed of elements which interact with elements in other sets to define an individual's cognitive style. This model has been used primarily in education.

The McKenny-Keen Model

This model assumes that information processing is based on communicating with the environment to obtain data (input and output) and organizing the data received to make predictions about the environment. In this conception of style, individuals develop conscious and unconscious modes of receiving and assessing information in order to solve problems and make decisions. Two major dimensions of individual differences in information-processing style are posited: information gathering and information organizing. The information-gathering dimension varies from, at one end, the "receptive" style to, at the other end, the "preceptive" style. Receptive thinkers focus on stimulus details and derive information from direct examination of stimulus attributes. They prefer to suspend judgment until a complete examination of the data set has been made. Preceptive thinkers use concepts as filters. They focus on relationships between items and look for deviations from conformity with their expectations. They jump from one section of the data to another, looking for cues. The information-organizing dimension has its endpoints in systematic versus intuitive thinking. Systematic thinkers structure problems in terms of some method and follow it through to a solution. They are very conscious of their approach. They discard alternatives quickly as they cycle through a process of increasing refinement in analysis. Intuitive thinkers are more likely to shift from one method to another, to use trial and error, to discard information, and to use cues which they may not be able to identify verbally. They will keep the overall problem in mind, continuously redefining the problem as they proceed. An individual will demonstrate a tendency to use one of four possible styles: intuitive-receptive, intuitive-preceptive, systematic-receptive or systematic-preceptive. This model has been used mainly in business (Keen, 1973).

The Cognitive-Dimensions Model

Messick (1970) lists nine dimensions of cognitive style which have been theoretically examined and empirically researched. Each dimension is thought to be bipolar. These dimensions will be briefly defined. Following this, a more extensive description of each dimension and its measures and a summary of representative research will be presented. Relationships among dimensions are not explicated in this model.

1. Field independent versus field dependent: an analytical versus global way of perceiving. Field independence entails a tendency to experience items aside from their backgrounds; it reflects ability to disregard the embedding context. Field dependence means a tendency to focus on the relationship of items to their background; it reflects a lack of ability to separate target from context but a strong sensitivity to environmental cues.

2. Reflective versus impulsive: an index of the speed and attention to detail with which hypotheses are selected and information is processed. A reflective person will consider various options before responding; an impulsive person will respond quickly with the first answer that occurs even though it may be wrong.

3. Scanning: extensiveness and intensity of attention. Individuals' styles may be to scan the entire field or to focus on selected elements in it.

4. Breadth of categorizing: range of inclusiveness in establishing the limits of categories. Broad "categorizers" will include many items and reduce the risk of exclusion. Narrow categorizers prefer to exclude items and reduce the risk of including an item which may not belong.

5. Conceptualizing style: conceptual differentiation versus compartmentalization. This dimension attempts to assess a person's tendency to form groupings of objects based on physical similarity versus functional relationships between objects.

6. Cognitively complex versus simple: number of dimensions employed in describing the environment. A high-complexity style perceives diversity and conflict; a low-complexity style perceives similarities.

7. Leveler versus sharpener: assimilation of fragmented stimuli. Levelers assimilate new stimuli with familiar elements and at extremes over-generalize. Sharpeners at extremes tend to over-discriminate.

8. Distractibility: susceptibility to distraction. Flexible individuals can concentrate on the task at hand without attending to interfering stimuli.

9. Tolerance for unrealistic experiences: a high-tolerance style indicates a readiness to accept and discuss experiences which conflict with conventional reality.

Field Independence versus Field Dependence

This dimension is by far the most thoroughly researched facet of cognitive style. Originating with Witkin and his associates over 30 years ago (e.g., Witkin, 1949, 1950), measures of field

independence/dependence (FI/FD) assess the ability of individuals to free themselves from irrelevancies. Field dependent individuals are less proficient at articulating a hidden figure in embedded context, a simple tune in a symphonic piece, or the true vertical in a tilted frame. Such individuals experience events globally. The relatively FI individual is more competent in analytical functioning, being able to restructure the perceptual field. Information-processing studies suggest that FI individuals may have a larger number of strategies available to them, may be more willing to utilize novel approaches, or may be more efficient in recognizing when a solution strategy is not working. FI individuals have greater skills in encoding, in long-term memory, and in selecting relevant stimuli to attend to. (See Davis & Cochran, 1982, for a discussion of FI from an information-processing perspective.) Witkin suggests that FI/FD is similar to Thurstone's flexibility of closure and to Guilford's adaptive flexibility.

This style has been found to be stable over time and across tasks. FD persons tend to prefer situations in which context and social skills are important. The supposition made is that FD persons are more attentive to context cues, are better at acquiring information from the social context, and are more receptive to external feedback and criticism (Leino, 1981). FI individuals tend to be more autonomous, to be better at academic problem-solving, and to obtain higher scores on intelligence tests, which measure in large part analytical skills. These differences in abilities find expression in vocational choices as well. Witkin, Moore, Goodenough, and Cox (1977) suggest that FI persons may tend to prefer occupations where emphasis is placed on analysis and structuring and where relationships with people are less important. In contrast, FD persons are likely to prefer domains in which social contact is an ongoing part of the job and where analytical skills are not crucial. Thus, FD persons might prefer occupations such as counseling, teaching, social work, nursing, personnel work, or the ministry, while FI persons may prefer jobs in biology, physics, mechanics, engineering, or mathematics.

FI/FD has been measured in several ways. Original measures were designed to assess how people orient themselves in space. In the Rod-and-Frame Test, an individual is seated in a totally darkened room and adjusts to true vertical a luminous rod which is surrounded by a tilted luminous frame. The standard administration consists of three series of eight trials each. In the first series, the frame and the subject's body are each tilted 28°, in either the same or opposite directions. In the second series, the frame and subject are tilted 28° in the other direction. In the third series, the subject remains vertical while the frame is tilted 28° to opposite sides. Witkin, Dyk, Faterson, Goodenough, and Karp (1962) suggested using only the third series of the test. The most frequently used scoring system for this test is the number of degrees away from true

vertical of the subject's final positioning of the rod summed across all trials. (A methodological analysis of scoring systems for the Rod-and-Frame Test is presented in McGarvey, Maruyama & Miller, 1977.) Variants of this test involve not tilting the chair in which the person is seated, or tilting the chair and rotating it to remove gravity cues. Stuart and Murgatroyd (1971) reported use of a portable Rod-and-Frame Test.

An alternate measure involving perceptual dependence was developed which did not rely on body position. This task involves locating an item in a visual field. The Embedded Figures Test requires subjects to locate simple geometric shapes within complex figures (Witkin, 1950). This twelve-item test has been expanded and revised with many different available forms: the Group Embedded Figures Test (Jackson, Messick & Myers, 1964), the Hidden Figures Test (French, Ekstrom & Price, 1963), the Children's Embedded Figures Test (Witkin, Oltman, Raskin & Karp (1971), a tactile embedded figures test (Axelrod & Cohen, 1961), and an auditory version of the test (White, 1954). Table 1 presents items used by Witkin. The most commonly reported correlation between the Rod-and-Frame Test and the Embedded Figures Test is about .50 (Long, 1972).

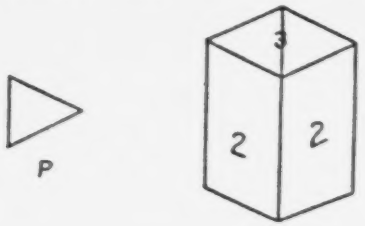
Internal consistency reliabilities of FI/FD measures cluster in the high .80s to .90s (Goldstein & Blackman, 1978). Other measures of FI/FD include the Hidden Figures Test (I-V), and the Hidden-Pictures Test. (See Cox & Gall, 1981, for a review of available measures and references.) It should be noted that the two major measures of FI/FD (Embedded Figures and Rod-and-Frame) are thought to measure somewhat different constructs, with the Rod-and-Frame Test being the purer measure. Embedded Figures has been found to have more overlap with general and spatial ability. In an analysis of 32 FI/FD and general ability measures, Linn and Kyllonen (1981) found the Rod-and-Frame Test to emerge as independent of ability tests, while Embedded Figures loaded on a fluid ability factor (with Object Assembly, Block Design, a paper folding test, and so on). They concluded that the Rod-and-Frame Test partially identifies a unique dimension.

Field independence (Embedded Figures measure) has been found to correlate with general visualization ability (Garrison & Trafton, 1981; Vernon, 1972) and with analytic factors of the Wechsler Test (Goodenough & Karp, 1961; Karp, 1963), although not with verbal comprehension or attention-concentration, and with perceptual speed (Garrison & Trafton, 1981). There is also a suggestion that field independence is associated with lateralization in hemispheric functioning, with right-handed individuals and those with a strong eye or ear preference being more field independent than left-handed persons or those without strong eye/ear preference (Bloom-Feshbach, 1980; O'Connor & Shaw, 1978; Oltman & Capobianco, 1967; Pizzamiglio, 1974). Field independence has been found to relate to color discrimination, with FI persons making fewer errors (Fine & Kobrick, 1980). It has also been found to relate to automobile accident involvement,

Table 1 - Embedded Figures Test Items

The simple figures are designated by a letter; the complex figures are designated by a letter and a number, the letter corresponding to that of the simple figure which it contains. Figures P and P-1 are the practice figures.

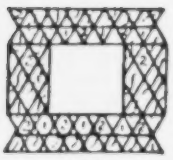
The specific colors used in each complex figure are represented by numbers; and wherever necessary the area covered by a given color is indicated by wavy lines radiating from the number. Figure A-2 remained uncolored. The colors to which the numbers refer are as follows: 1—red, 2—blue, 3—orange, 4—yellow, 5—brown, 6—dark green, 7—light green, 8—black.



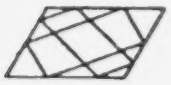
P

P-1

A



A-1



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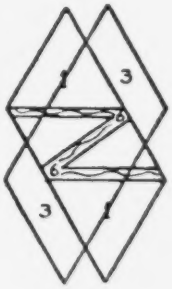
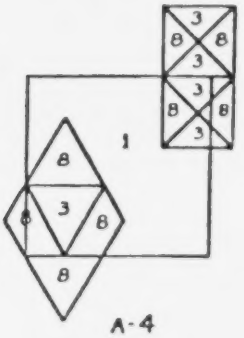
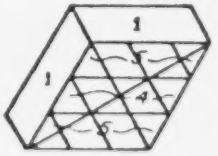


A-3



A-4



A-5

with FI persons having fewer accidents (Mihal & Barrett, 1976). Rod-and-Frame Test performance was found to correlate .40 with Wiggly Block scores, .25 with Memory for Design, and .20 with Pitch Discrimination (Johnson O'Connor Research Foundation, 1975).

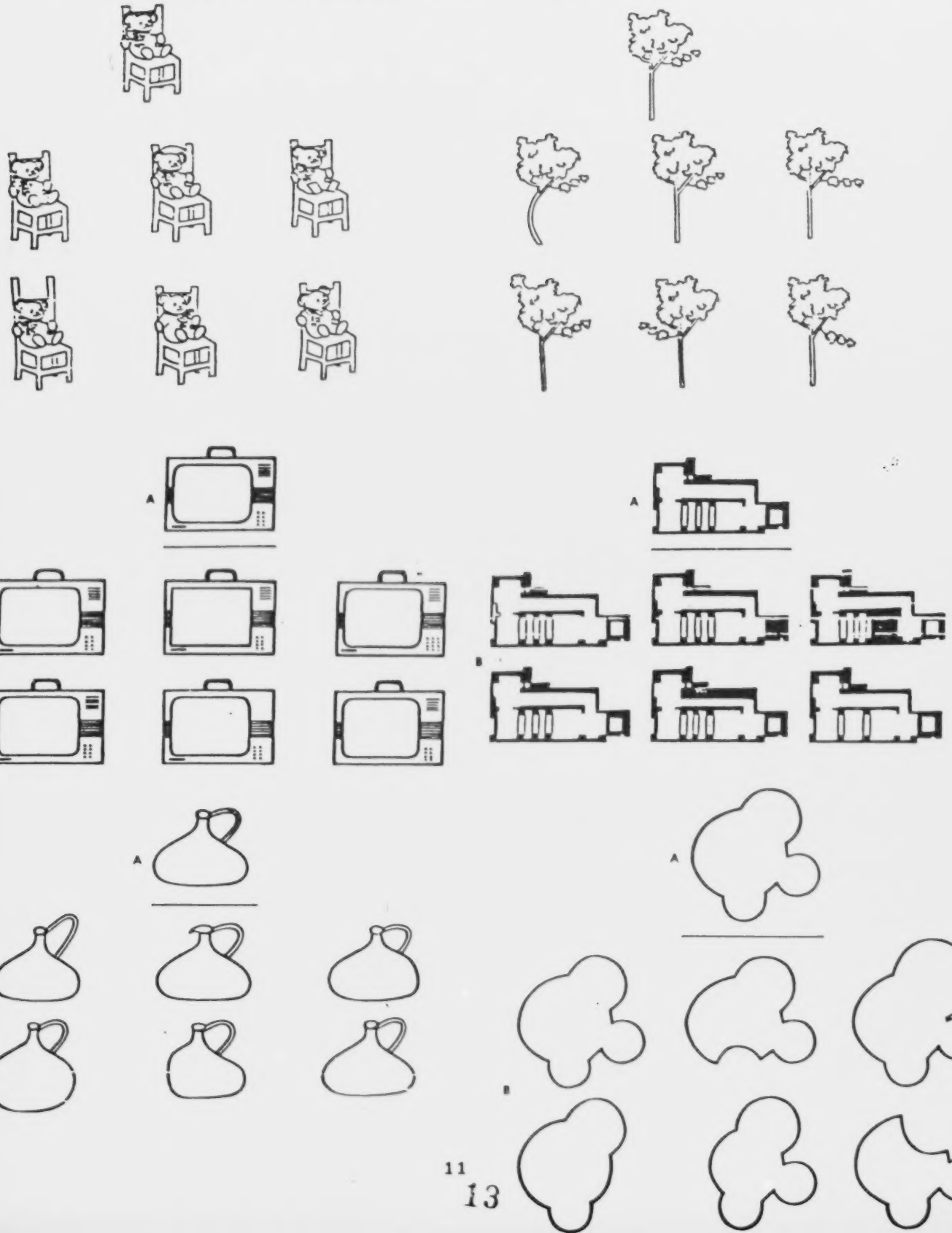
Reflective-Impulsive

Kagan (1966) defines this dimension as "the degree to which a subject reflects upon the differential validity of alternative solution hypotheses in situations where many response possibilities are available simultaneously. In these situations, the subjects with fast tempo impulsively report the first hypothesis that occurs to them, and this response is typically incorrect. The reflective subject on the other hand, delays a long time before reporting a solution hypothesis and is usually correct" (p. 119). Drake (1970) found that impulsive individuals do not see or consider all options before responding. More recent work (Cooper, 1982) suggests that differences in speed of processing may represent stable individual characteristics, at least in processing of visual information. She suggests that persons tending to use a global processing strategy have a quicker response time when comparing a model to a target figure than persons who tend to use an analytic strategy.

Research suggests individuals with an impulsive cognitive style to be at a disadvantage academically. Impulsive students tend to respond more rapidly and make more errors than reflective students (Kagan, Pearson & Welch, 1966). Messer (1970) found a relationship between tendency toward impulsivity and school failure. Kogan (1971) found correlations between academic ability measures and response latency on a match-to-standard task to be positive, whereas correlations with error rate were negative. Leino (1981), however, suggests that the response time component is relatively independent of general abilities. Boyden and Gilpin (1978) found both latency and errors to be independent of Stroop test performance. (The Stroop test measures distractibility.)

The Matching Familiar Figures Test (Kagan, 1969) has most commonly been used to assess the impulsive-reflective dimension of cognitive style. With this test, the subject looks at the standard (a familiar figure) and selects the standard's replicate from a number of variants. Sample items may be found in Table 2. Both latency and number of errors on the multi-item test are measured. Subjects are classified as impulsive if they are below the median on latency and above the median on errors. Conversely, subjects are classified as reflective if above the median on latency and below the median on errors. Subjects not falling into either of these two groups are not classified, and their data is discarded. Reliabilities reported on the test have been low to moderate (Kagan, 1965). For example, O'Keeffe and Argulewicz (1979) report test-retest reliabilities of .51 for latency and .44 for error scores (over a 10-week period) for an

Table 2 - Matching Familiar Figures Test Items



adult group. Internal consistency reliabilities of .89 (latency) and .50 to .62 (errors) have been reported (Messer, 1976). Norms for children and for adults are available (Heckel, Hiera, Laval, & Allen, 1980; Paulsen & Arizmendi, 1982; Salkind, 1978).

An alternative measure for this dimension may be the JOC Analytical Reasoning test, using latencies to first response and errors (on first responses) to classify individuals.

Scanning

Scanners attend first to the entire conceptual field and then more intensively to parts in a sequential fashion. Scanners tend to be sensitive to background irregularities. Focusers attend in a narrowed, discriminating way to certain aspects of the field while ignoring the overall field. They find relevant parts and features and ignore the irrelevancies. Focusers seem to accept perceptual fields less critically than scanners, who are more cautious and less trusting. Originated by Schlesinger (1954) and modified by Gardner, Holzman, Klein, Linton and Spence (1959), focusing-scanning concerns the way attention is deployed.

Gardner (1961) investigated scanning using error in judgment of size estimation. Subjects adjusted a circular patch of light until it appeared equal in size to a disk projected on the wall or held in their hands. Scanners would provide closer matches between the two disks than focusers. Errors in size estimation were attributed to low attention deployment. Later research included data on the number and duration of eye fixations (Gardner & Long, 1962).

Research with scanning has been concerned with its relationship to personality structures rather than to educational or vocational choices (Kogan, 1971).

Breadth of Categorization

This dimension reflects differential tolerance for error types. The narrow categorizer is considered to be more conceptually conservative than the broad categorizer, who is more tolerant of marginal instances of a concept. The narrow categorizer minimizes the risk of errors of inclusion while the broad categorizer limits errors of exclusion. Kogan (1971) found individuals to be consistent in style across quantitative, verbal and geometric tests.

Breadth of categorization has been found to be related to creativity (Kogan, 1971), with broad categorizers displaying more imaginative possibilities in creative tasks. Bruner and Tajfel (1961) found a positive relationship between narrowness of categorizing and intelligence.

Tests of this cognitive style include Pettigrew's (1958) 20-item paper-and-pencil questionnaire (see Table 3). In this task,

1. It has been estimated that the average width of windows is *34 inches*. What do you think:
   a. is the width of the widest window . . .
      1. 1,363 inches (3) 3. 48 inches (0)
      2. 341 inches (2) 4. 81 inches (1)
   b. is the width of the narrowest window . . .
      1. 3 inches (2) 3. 11 inches (1)
      2. 18 inches (0) 4. 1 inch (3)
2. Ornithologists tell us that the best guess of the average speed of birds in flight would be about *17 m.p.h.* What do you think:
   a. is the speed in flight of the fastest bird . . .
      1. 25 m.p.h. (0) 3. 73 m.p.h. (2)
      2. 105 m.p.h. (3) 4. 34 m.p.h. (1)
   b. is the speed in flight of the slowest bird . . .
      1. 10 m.p.h. (1) 3. 12 m.p.h. (0)
      2. 2 m.p.h. (3) 4. 5 m.p.h. (2)
3. The average length of whales in the Atlantic Ocean has been estimated by zoologists to be roughly *65 feet*. What do you think:
   a. is the length of the longest whale in the Atlantic Ocean . . .
      1. 120 ft.....(2) 3. 86 ft.....(1)
      2. 190 ft.....(3) 4. 75 ft.....(0)
   b. is the length of the shortest whale in the Atlantic Ocean . . .
      1. 6 ft.....(3) 3. 52 ft.....(0)
      2. 43 ft.....(1) 4. 21 ft.....(2)
4. Shipping authorities have calculated that the average weight of merchant ships registered with the U.S. Maritime Commission in 1946 was *5,705 tons*. What do you think:
   a. is the weight of the heaviest ship registered with the commission . . .
      1. 10,500 tons...(1) 3. 23,000 tons...(2)
      2. 62,000 tons...(3) 4. 7,500 tons...(0)
   b. is the weight of the lightest ship registered with the commission . . .
      1. 3,900 tons...(0) 3. 2,700 tons...(1)
      2. 1,100 tons...(2) 4. 2 tons...(3)
5. Weather officials report that during this century Washington, D.C. has received an average rainfall of *41.1 inches* annually. What do you think:
   a. is the largest amount of rain that Washington has received in a single year year during this century . . .
      1. 82.4 inches (3) 3. 63.7 inches (2)
      2. 45.8 inches (0) 4. 51.2 inches (1)
   b. is the smallest amount of rain that Washington has received in a single year during this century . . .
      1. 20.2 inches (2) 3. 9.9 inches (3)
      2. 36.3 inches (0) 4. 29.7 inches (1)
6. An average of *58 ships* entered or left New York harbor daily during the period from 1950 through 1955. What do you think:
   a. was the largest number of ships to enter or leave New York in a single day during this period . . .
      1. 69 ships (0) 3. 76 ships (1)
      2. 153 ships (3) 4. 102 ships (2)
   b. was the smallest number of ships to enter or leave New York in a single day during this period . . .
      1. 34 ships (1) 3. 16 ships (2)
      2. 3 ships (3) 4. 43 ships (0)
7. For the past twenty years, Alaska's population has increased an average *3,210 people* per year. What do you think:
   a. was the greatest increase in Alaska's population in a single year during these twenty years . . .
      1. 6,300.....(2) 3. 3,900.....(0)
      2. 21,500.....(3) 4. 4,800.....(1)

   b. was the smallest increase in Alaska's population in a single year during these twenty years . . .
      1. 470.....(3) 3. 980.....(2)
      2. 1,960.....(1) 4. 2,520.....(0)
8. Boating experts estimate that the average speed of all sailing craft in America is around *4.1 knots*. What do you think:
   a. is the speed of the fastest sailing boat in America . . .
      1. 8.2 knots (1) 3. 5.9 knots (0)
      2. 30.7 knots (3) 4. 21.3 knots (2)
   b. is the speed of the slowest sailing boat in America . . .
      1. 3.3 knots (0) 3. 2.2 knots (1)
      2. 0.6 knots (3) 4. 1.2 knots (2)
9. Book review editors guess that around *300 new American novels* have appeared annually since World War II. What do you think:
   a. is the largest number of novels to be published in America in a single year during this period . . .
      1. 380 novels (0) 3. 870 novels (3)
      2. 495 novels (1) 4. 620 novels (2)
   b. is the smallest number of novels to be published in America in a single year during this period . . .
      1. 145 novels (2) 3. 90 novels (3)
      2. 205 novels (1) 4. 260 novels (0)
10. Between 1900 and 1940 there was an average of *48 lynchings* per year in the United States. What do you think:
   a. was the largest number of lynchings in any one year during this period in the United States . . .
      1. 79.....(2) 3. 53.....(0)
      2. 63.....(1) 4. 135.....(3)
   b. was the smallest number of lynchings in any one year during this period in the United States . . .
      1. 1.....(3) 3. 33.....(0)
      2. 11.....(2) 4. 19.....(1)
11. It has been calculated that the average time for all trains in 1953 from New York City to Washington, D.C. was *285 minutes* (4 hours and 45 minutes). What do you think:
   a. was the time of the slowest train from New York City to Washington in 1953 . . .
      1. 337 min....(1) 3. 396 min....(2)
      2. 304 min....(0) 4. 483 min....(3)
   b. was the time of the fastest train from New York City to Washington in 1953 . . .
      1. 236 min....(1) 3. 268 min....(0)
      2. 202 min....(2) 4. 145 min....(3)
12. The average number of births in the world per day during 1955 has been computed to be *27,440*. What do you think:
   a. was the largest number of births in the world in any one day during 1955 . .
      1. 36,501.....(2) 3. 49,876.....(3)
      2. 28,207.....(0) 4. 30,023.....(1)
   b. was the smallest number of births in the world in any one day during 1955 . . .
      1. 26,340.....(0) 3. 14,330.....(3)
      2. 24,725.....(1) 4. 19,704.....(2)
13. When all of the world's written languages are considered, linguists tell us that the average number of verbs per language must be somewhere around *15,000*. What do you think:
   a. is the largest number of verbs in any single language . . .
      1. 21,000.....(1) 3. 50,000.....(3)
      2. 18,000.....(0) 4. 30,000.....(2)
   b. is the smallest number of verbs in any single language . . .
      1. 1,000.....(3) 3. 5,000.....(2)
      2. 13,000.....(0) 4. 10,000.....(1)

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subjects are given a category and a list of parameter alternatives and are asked to specify reasonable parameters. The category might be the length of whales, time to run a mile, or heights of 8-year-old boys. The subject would choose estimates of extreme values.

Another test presents in turn a number of stimuli which vary over some limited range. Bruner and Tajfel (1961) used cards with around 20 spots on them. For each card, subjects said whether they thought there were 20 spots. A broad categorizer would provide more "yes" responses.

Other forms of tests include a test in which subjects choose all words which could be used as synonyms for a given word and a test in which geometric figures are chosen as belonging to a class based on acuteness of angles (Kogan, 1971).

Conceptualizing Style

Individuals have been shown to have strong tendencies to organize discrete pieces of information into categories and subcategories. Such information can usually be grouped by a number of different classification schemes, and the particular grouping schemes favored by different individuals appear to be (to a degree) consistent across bodies of information. Kagan, Moss, and Sigel (1963) identified three styles of classification: (1) analytic-descriptive, in which objects are grouped based on some concrete similarity (e.g., all have spots), (2) inferential-categorical, in which the grouping criterion is an inferred rather than a physical attribute (e.g., they're all sportsmen) and (3) relational-contextual, in which objects are grouped based on relationships (e.g., mother and child). The second category was later dropped, leaving a bipolar style of analytic-relational. Analytic grouping tends to increase with age, but remains affected by the nature of the material used in the test.

Messick and Kogan (1963) suggested that two processes operate in defining conceptualizing style: conceptual differentiation (which represents the number of groups created) and compartmentalization (which reflects the number of single items not placed in any category). These authors found conceptual differentiation to be positively related to vocabulary level/verbal knowledge and to decrease with age, suggesting an age-related shift from perception-dictated differences to a synthesis-based analysis of similarities (Bruner, Oliver & Greenfield, 1966). Compartmentalization has been found to be negatively related to creativity (Frick, Guilford, Christenson & Merrifield, 1959).

No standard instrument exists for assessing conceptualizing style, but a standard type of task exists. The basic task used is to present subjects with a set of objects and ask them to sort the objects into as many categories as they wish. Gardner (1953)

used 73 objects; Clayton and Jackson (1961) developed a 50-item form of an object sorting test. Examples of objects are a yellow pencil, small corks, a nail, a white doll shoe, a cigar, a piece of chamois skin, etc. After all objects are grouped, subjects are asked for a rationale for their groupings. Test score is simply the number of groups formed, with single items counting as additional groups. (A list of the 73 items used by Gardner may be found in Gardner et al., 1959.) Conceptual differentiation is assessed by counting the number of categories formed with more categories indicating greater differentiation.

Conceptualizing style has been found by some (Gardner & Schoen, 1962; Murdock & Van Bruggen, 1970) to be related to breadth of categorization. Others (Sloane, Carlow & Jackson, 1963; Wallach & Kogan, 1965) have found no relationship between the two.

Cognitive Complexity versus Simplicity

This facet of cognitive style concerns itself with individual differences in the tendency to perceive the world in a complex, multidimensional way. It reflects individuals' tendencies to perceive similarities and differences among stimuli. Originally studied by Kelly (1955) when he investigated personal constructs about relationships, it has not been particularly well-defined in the cognitive style literature. The task Kelly used to assess cognitive differentiation is the Role Construct Repertory Test (REP Test). Subjects are asked to think of two or three (or more) people they know and to state how they are alike and how they are different. Table 4 presents an example of the test format. Later researchers changed the format by having subjects respond to constructs provided by the examiner rather than generating their own (Bieri, Atkins, Briar, Leaman, Miller & Tripodi, 1966). Reliabilities (generally test-retest) range from .6 to .8 (Goldstein & Blackman, 1978).

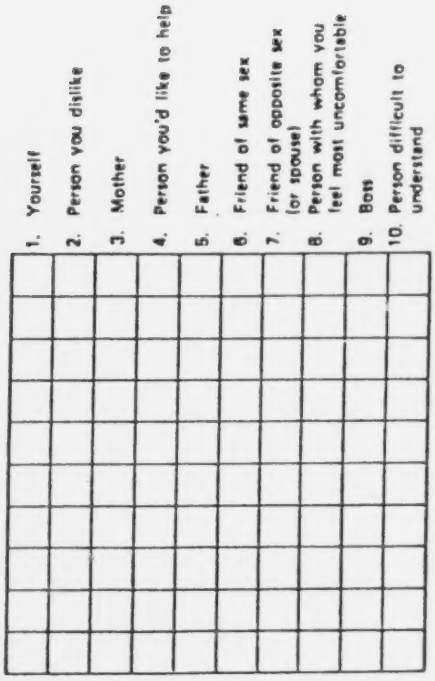
There has been some concern about the generality of cognitive complexity. Allard and Carlson (1963) found complexity to generalize across visual, semantic, and behavioral content areas. Moderate correlations across sets have been obtained when the degree of personal reference involved was varied.

Studies investigating cognitive complexity and intelligence have generally found no significant relationship between the two constructs.

Although Kelly's REP test has been used in much of the research in cognitive complexity, Harvey, Hunt, and Schroder (1961) conceptualized this attribute somewhat differently than did Kelly. They view it as position on an abstractness-concreteness dimension. These researchers used sentence completion tests involving integration of subordinate and superordinate concepts (Harvey, 1966). These tests are scored on criteria such as absoluteness of expressed beliefs, consideration

Table 4

Example of REP Test Format


1. Yourself
2. Person you dislike
3. Mother
4. Person you'd like to help
5. Father
6. Friend of same sex
7. Friend of opposite sex (or spouse)
8. Person with whom you feel most uncomfortable
9. Boss
10. Person difficult to understand

+3	+2	+1	−1	−2	−3
Outgoing			Shy		
Adjusted			Maladjusted		
Decisive			Indecisive		
Calm			Excitable		
Interested in others			Self−absorbed		
Cheerful			Ill humored		
Responsible			Irresponsible		
Considerate			Inconsiderate		
Independent			Dependent		
Interesting			Dull		
+3	+2	+1	−1	−2	−3

of modifying circumstances, dependence on external authority, acceptance of social standards, concern for personal relationships, etc.

Leveling-Sharpening

Although the concept originated with Wulf (1922), Klein and Schlesinger (1951) and Holzman (1952) were the first to define leveling-sharpening as a cognitive style. Sharpening was defined as the tendency to maximize perceived differences. A sharpener would perceive small gradients of difference between figure and ground. Leveling was defined as a propensity to minimize perceived differences and to experience two stimuli as the same rather than different.

The Schematizing Test has been used to measure this cognitive style. Ten series of five squares of increasing size are projected onto a screen. There is a systematic increase in size from one series to the next. Individuals are requested to state whether the new square is different in size from the old. In the first set, the sides of squares range from 2-7". In the second set, they range from 3-8" with the final set ranging from 9-14". Levelers do not notice the gradual increase in size. At the beginning, a 6" square is "large" while at the end a 10" square is "small." Sharpeners appear to keep the absolute size in mind not just the relative size. In addition, this test has been used in other modalities (loudness of tones, heaviness of weights) with similar results. (A more complete description of the Schematizing Test with scoring instructions is given in Gardner et al., 1959).

Gardner and Lohrenz (1960) used story retelling (the children's game of "telephone") to assess leveling-sharpening. Levelers lost more of the original story in detail and order of events than did sharpeners.

Santostefano (1964) developed tests which consist of sequentially displayed pictures (e.g., of a house or wagon) in which parts of the object are gradually omitted/added (e.g., the front wheel, the right section of the canopy).

Butler (1977) commented that increased precision in instrumentation is necessary before leveling-sharpening measures can be said to be reliable and valid. It was suggested that computer administration of stimuli would assist in standardizing the test.

Distractibility

This dimension involves the degree to which individuals selectively attend to relevant stimuli and withhold attention from irrelevant stimuli. Santostefano (1969) named this construct "field articulation." Persons who are good articulaters can attend to a task and ignore competing demands.

The most frequently used measure of distractibility is the Color-Word Test, introduced in the United States by John Stroop in 1935. It consists of three parts, all of which are timed. In the first part, subjects read 100 color names (red, green, blue and yellow) typed in random order in black ink. In the second part, subjects name the color of 100 rectangular color patches. In the third part, subjects name the colors of 100 words typed in incongruent colors of ink (e.g., blue typed in red ink). Reliabilities for this test are reported at about .8 to .9 (Golden, 1975). Reading time for part II is expected to be longer than for part I. In part III, two responses are competing: the overlearned tendency to read words and the equally overlearned tendency to recognize colors. The requirement to name the colors, is, however, unfamiliar. Part III responses depend on restriction of attention to color and active inhibition of the more readily available response to the words. Gardner et al. (1959) reported that subjects speak more loudly, assume exaggerated body positions, and report feeling that they've "lost their poise" when taking this test.

Another measure of this cognitive style is the free association test. The assumption of this test is that flexible subjects will produce more remote associations while constricted subjects will produce associations that are closer to the target word.

In studies relating field independence/dependence to distractibility, Karp (1963), Sack and Rice (1974), and Houston (1969) concluded that the two measures were unrelated. Friedman (1971) found a significant relationship between speed in color-word reading and color naming (parts I and II of the Color-Word Test) and intelligence.

Tolerance for Unrealistic Experiences

This dimension of cognitive style has been assessed by tests of apparent movement. The illusion of apparent movement is produced with a tachistoscope, as in the flicker-fusion test, but with two pictures projected alternately in the visual field. As the presentation rate increases, the two figures appear to move as a single picture. Measurement (in cycles per second) is taken when the subject first reports the illusion. Subjects are informed prior to testing that the movement is an illusion. Tolerant subjects report the illusion earlier than intolerant subjects. Intolerant individuals appear to have a more restricted range in which they report the illusion. (Scoring instructions and further description may be found in Gardner et al., 1959).

Another measure of tolerance was developed by Kogan (1971). This measure uses reversible figures. Each visual figure can be perceived in two different ways by reorganizing the perceptual field. The ability to reverse the field and to resist reversal under instruction to do so has been related to tolerance for unrealistic experience.

A further measure of tolerance is the number of responses to ink blots on the Rorschach Test. Individuals who are more tolerant will produce more responses which supersede the visual reality of the cards. This measurement strategy could also be used with the JOC Foresight test.

Other Definitions of Cognitive Style

Visual-Haptic

Visual-perceptual persons use their eyes as their primary sensory medium while haptic persons rely mainly on kinesthetic and bodily orientation information. Lowenfeld (1945) developed five tests designed to categorize individuals. These exercises required subjects to combine partial visual impressions into whole visual images (Integration of Successive Impressions), to draw items, to estimate the number of floors in an imagined building, to make associations with words, to form visual images of items experienced kinesthetically, and to identify figures perceived through tactile experience. These tests are based on the idea that "visuals" have the ability to see a whole, see its component parts, and resynthesize the parts into a whole, while the "haptic" is unable to do this. Visuals react to stimuli as spectators while haptics react more emotionally and put themselves into the situation. Visuals have the ability to visualize tactile experiences and to maintain visual images mentally while haptics do not. A variation of one of Lowenfeld's tests was constructed by the U.S. Army Air Corps (1944). This 38-item test presents a pattern of which only a small section at a time is visible behind a moving slot. The subject is then shown five similar variants and must select the one seen behind the slot. Visuals, having the ability to integrate parts into visual wholes, perform well. Haptics, who do not integrate segments into wholes, do not. In testing over 1,000 individuals across age and sex, Lowenfeld found approximately 45% to be visual, 23% haptic and 30% indefinite. Similar distributions have also been found in studies of the relationship between modality preference and alpha rhythms (Drews, 1958; Walter, 1963). Another measure of haptic-visual style was used by Kagan, Rosman, Day, Albert, and Phillips (1964). It is a match-to-standard test with the standard presented haptically and the alternatives visually. An example of the test presentation may be found in a study by Rupert and Baird (1979) of first- and second-grade children. In this test, the child was required to put his hands through two holes in a specially designed wooden box and was given a wooden geometric form about 3" square to hold. An array of five drawings, one of which was the outline of the wooden form, was simultaneously placed in front of the child. Latency and accuracy of response were recorded. The test consisted of ten items. In a variation of this test, the wooden forms are familiar objects as well as geometric forms which make up a 20-item test.

In relating perceptual type to academic achievement, it has been found that visual types perform better in mechanical drawing (Erickson, 1966), have higher reading achievement levels (Erickson, 1969) and have higher mathematics achievement levels (Bruning, 1974).

Analytical/Global

A number of researchers (e.g., Santostefano, 1969; Wachtel, 1968) have been concerned with analytic and global styles of thinking. The following general terms have been used in describing the endpoints of this proposed style: analytical, rule-bound versus flexible, gestalt, global; fixed versus mobile; differentiated versus diffuse. Studies of problem-solving (e.g., Brumby, 1982) often categorize style as analytic, trial-and-error, or insightful. The person with an analytic style would tend to be comfortable with well-discriminated items and with systematic methods of problem-solving. The individual with a global orientation would, in contrast, be comfortable with information about the overall situation with a few specifics and with an insightful, less well-defined approach to problem-solving.

Verbalizer-Visualizer

This measure of cognitive style assesses whether an individual tends to think in verbal terms, using sequential processing of information, or in visual terms, using parallel processing. Taken from Paivio's (1971) 86-item "ways of thinking" questionnaire, the 15-item Verbalizer-Visualizer Questionnaire (VVQ) has been reported as being sufficiently reliable for research purposes (Richardson, 1977; Spoltore & Smock, 1983, with test-retest coefficients ranging from .48 to .91; Warren & Good, 1979). Scores on the VVQ have been found to relate to breathing pattern and lateral eye movement.

Other Types of Tasks Used in Research

Puzzle-insight problems have been used in problem-solving investigations. These tasks are games in which there is a very limited number of ways to reach a stated goal. An example of these types of tasks is Maier's (1945) two-string problem. Briefly, the problem is: Two strings are hanging from the ceiling at such a distance apart that a person is unable to reach one while holding onto the other. Each string is just long enough to reach to the floor. The goal is to tie the ends of the strings together without removing them from the ceiling. Solutions involve (1) using an anchor--tying one string to a heavy object somewhere between the two; (2) extension--tying a length of cord to one of the strings; (3) using a hook--using a pole or some object to catch the end of the string that is out of reach; or (4) using a pendulum--tying a weight to the end of one string and swinging it over to the other. These tasks have been

used as measures of a person's flexibility or rigidity in using common objects in novel ways.

Process problems are structured to provide a number of discrete points at which an individual must make a decision and where that person's decision is recorded. An example of this is the tab item technique used in medical diagnosis problems. The problem (presenting complaint) and a file of possible questions with answers (e.g., lab tests and results, family history, medical history) are provided to the subject who is allowed to pull tabs to get certain information. Scoring of a problem may include the number of questions asked, the order in which questions were asked, whether a correct solution was obtained, or the type of questions asked. Feldhusen, Houtz, and Ringenbach (1972) cite research using various types of process problems.

SUMMARY OF RELATIONSHIPS AMONG MEASURES

Only a small number of the many measures of cognitive style have been studied in relation to each other or to ability and aptitude measures. Factor analytic studies have included one or two measures of cognitive style and a series of perceptual/cognitive ability variables (Kinney & Luria, 1980; Mos, Wardell & Royce, 1974; Riding & Dyer, 1983; Widiger, Knudson & Rorer, 1980). Results of these analyses have not, however, been consistent. Field independence/dependence has been found to relate to visualization ability (e.g., mental rotation), to analytic ability, to authoritarianism, and to lateralization. Breadth of categorization and conceptualizing style have both been found to relate to creativity. These two and distractibility have been found to relate to IQ. Reflectivity-impulsivity and the visual/haptic style predict educational achievement.

Field independence/dependence has emerged as a factor distinct from "conceptual style" (concrete-abstract) and has been found to be independent of cognitive complexity, breadth of categorization, and conceptualizing style. It has been found to be both related to and unrelated to reflectivity-impulsivity and distractibility in various studies. Breadth of categorization has been found to be unrelated to conceptualizing style. Reflectivity-impulsivity has been found to be unrelated to distractibility and to be both related and unrelated to an analytic versus a relational conceptual style.

The lack of convergence among cognitive style measures suggests that there are a multitude of cognitive styles or of dimensions of cognitive style. There is some argument (Widiger et al., 1980) that FI/FD is an ability--unipolar and trainable to some extent--rather than a style. There is also discussion of whether existing measures of cognitive style in fact tap that construct. Theoretically, a measure of cognitive style should

bear little relationship to achievement or intelligence. If cognitive style reflects a bipolar trait, one style should be advantageous in certain situations while another style produces superior performance in others. Research with FI/FD provides some support for this dimension as a measured style in which FI and FD are, respectively, more advantageous in different settings.

Questions which are yet to be answered regarding cognitive styles include: (1) Are styles distinguishable among themselves and can they also be differentiated from general intelligence and specific ability measures? (2) Are cognitive styles context-dependent and, if so, what is the mechanism controlling choice of style to be used in a specific context? and (3) How can cognitive styles be reliably measured?

RECOMMENDATIONS

Assuming cognitive style to be multidimensional, multiple measures may be used to assess various dimensions. The dimensions which seem the most conceptually comprehensive and potentially independent are field independence/dependence, distractibility, tendency to use global versus analytic problem-solving strategies, and preferred medium for obtaining information (e.g., visual/haptic; verbal/visual). Each of these will be briefly reviewed, along with two other dimensions discussed earlier.

1. Field independence/dependence (flexibility): Recommended with the note that FI/FD has been found to correlate with outside measures of analytical reasoning and so may not be independent of the JOC Analytical Reasoning test. FI/FD has been shown, with some consistency, to relate to vocational preference and has been well researched. There is debate about whether it is a style or a perceptual judgment ability, but in either case it could be a useful measure if shown to be empirically independent of the other Johnson O'Connor tests. Further, instruments assessing this style already exist and have been shown to have adequate reliability. The instrument recommended is the portable Rod-and-Frame, which takes only a short time to administer. It has been found to relate to vocational preference more often than the alternative (the original Rod-and-Frame) and the paper-and-pencil (embedded figures) measure. All have been found to have adequate reliability and to correlate with each other.

2. Distractibility (concentration): Recommended. This facet has been found to be independent of FI/FD and has been extensively researched (although not related to vocational preference). Its predominant measure, the Stroop Color-Word Test, is highly reliable, easy and quick to administer, relatively nonthreatening, and fun to take. The test is, again,

a performance test rather than a paper-and-pencil test and is one that is easily manufactured and is commercially obtainable.

3. Analytic/global approach to problem-solving: Recommended. This idea of cognitive style appears repeatedly in the problem-solving literature. As a style, it may overlap to some extent with the reflective-impulsive and scanning dimensions. It may also overlap with the two reasoning tests (inductive and analytical) given by Johnson O'Connor. Unfortunately, there are no general measures of this style. Measures used in problem-solving research have been subject- and study-specific. Thus, an experimental test needs to be developed to assess this construct.

4. Preferred information medium: Marginally recommended. It has long been suggested that people differ in ways of perceiving the world and in ways of thinking. Some people may use visual imagery while others attend more to verbal or auditory information. However, there is little empirical evidence of effects of this attribute on performance, though information-processing abilities in different media vary.

5. Reflectivity-impulsivity: Recommended. This facet of cognitive style has also been well researched, with more recent findings indicating it may be a measure of global/analytic perceptual style. As such, it would provide a useful measure in itself and as a criterion measure in validation of any newly developed test of global/analytic problem-solving style. Further, it is suggested that the Object Assembly test from the Wechsler Adult Intelligence Scale be administered as an additional validation for global/analytic style. In addition, the following facet of cognitive style may be incorporated as a subsidiary measure in an existing Johnson O'Connor test.

6. Conceptualizing style: Not recommended as an independent test. Grouping of information seems to be assessed by the Inductive Reasoning (IR) test on the Johnson O'Connor test battery. If conceptualizing style were to be used, it might be made a subsidiary measure on the IR test, provided analytic-relational groupings are possible for each item. It is unclear that existing measures of conceptualizing style are pure. Items may be grouped in many ways, based on elementary to sophisticated criteria. A count of the groupings does not necessarily provide information about the grouping criteria.

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